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University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN No. 199 APRIL, 1912

ORCHARD NOTES.

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BULLETIN No. 199.

ORCHARD NOTES.

W. W. BONNS.

INTRODUCTION.

From 1891 to 1907 the results of the experimental work in pomology obtained by the late Dr. W. M. Munson were for the most part published by the Station from time to time under the title "Orchard Notes."

From 1907 to 1909 the Station carried on no investigations upon orchard problems. The present accumulation of data on orchard management, together with notes of pomological interest, is the first publication under the old title since the re-establishment of work in orcharding in 1909. The change in personnel that becomes effective April 1, 1912, makes it advisable to publish at this time the observations of the past two years on orcharding.*

Previous to 1909 the experimental work in pomology was carried on under considerable handicap. On account of soil and climatic conditions, the location of the Station at Orono is not favorable for experimental studies with the varieties of fruit grown in the apple sections of the State. Hence such work was of necessity much restricted and dependent upon the generosity of individuals sufficiently interested in the pomological development of the State to place part of their orchards at the disposal of the Station.

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*The accounts of the spraying experiments in 1910 and 1911 have been published separately (Bulletins 189 and 198 of this Station) and no discussion thereof will herein be given.

Under such conditions valuable and interesting data was obtained. At the same time it was clearly recognized that the prime requisite for the accumulation of data on orchard management and for the proper attack of scientific orchard problems, upon the solution of which depend the fundamental practices of pomology, was the use of land for orchards for a continuous, indefinite period. Such work could only be successfully prosecuted by this Station in the Maine apple region in orchards under State ownership.

The legislative appropriation and subsequent purchase of Highmoor Farm, Monmouth, in 1909 met the necessary conditions in regard to ownership. The condition of the trees, however, at the time the Station assumed control in the summer of that year was such that only a small part of the orchards was suitable for any real work of investigation. It was therefore imperative that the orchards as a whole be brought into vigorous condition before they could be regarded as proper media for experimental work. The need for restoration as a prerequisite for experimentation is obvious from a consideration of the orchard conditions in the fall of 1909.

CONDITION OF HIGHMOOR ORCHARDS, 1909.

The orchards at Highmoor Farm, consisting originally of 5000 trees, were set out about 25 years previous to the above date. No records are available giving data upon the exact year of planting, the number of each variety set, the replacing of the original trees or the subsequent treatment of the orchards. The trees received indifferent, if any, treatment at times, according to the ideas of the several owners who preceded the Station. Some plots were evidently fertilized occasionally with barnyard manure, but there is no evidence that any system of intelligent orchard management had been followed and no attempt had been made to handle the trees by up to date horticultural practices up to the time the Station came into possession. On the contrary, persistent neglect seems to have been the case for many years.

The number of trees in the orchards proper in the fall of 1909 was a little over 3100, set 25 by 25 feet apart. With the exception of a small block of about two score trees near the farm buildings, which will not be considered, and a scattering

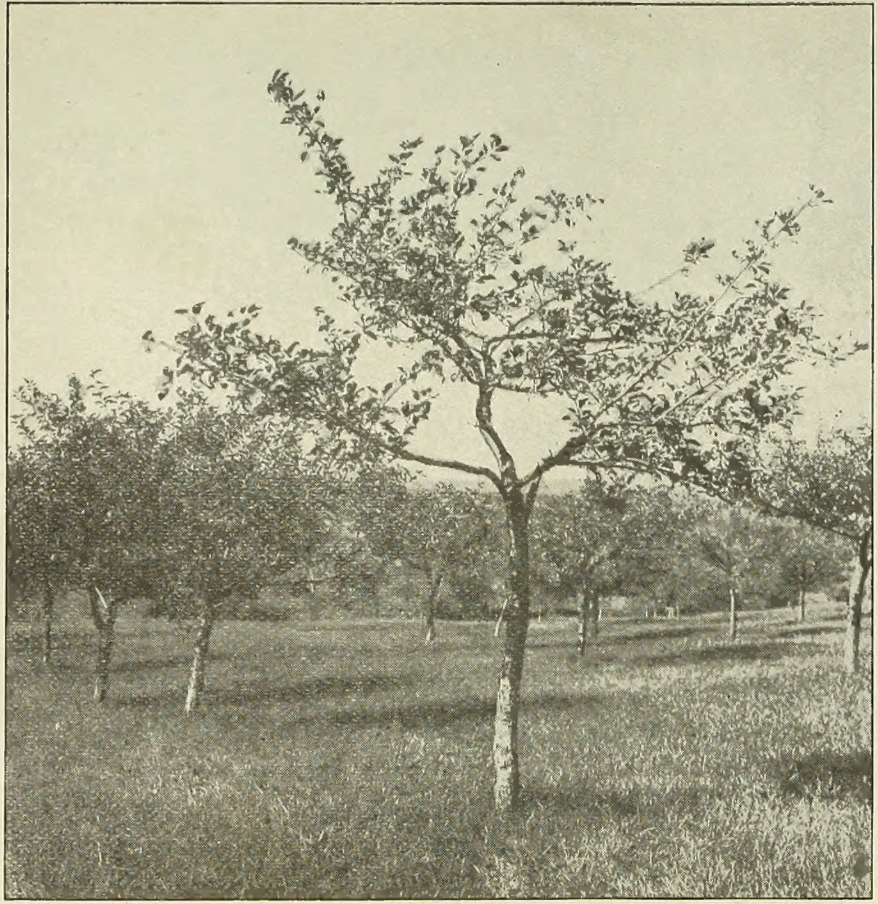

Fig. 12. Average Tree in Baldwin Orchard, Oct. 1909.

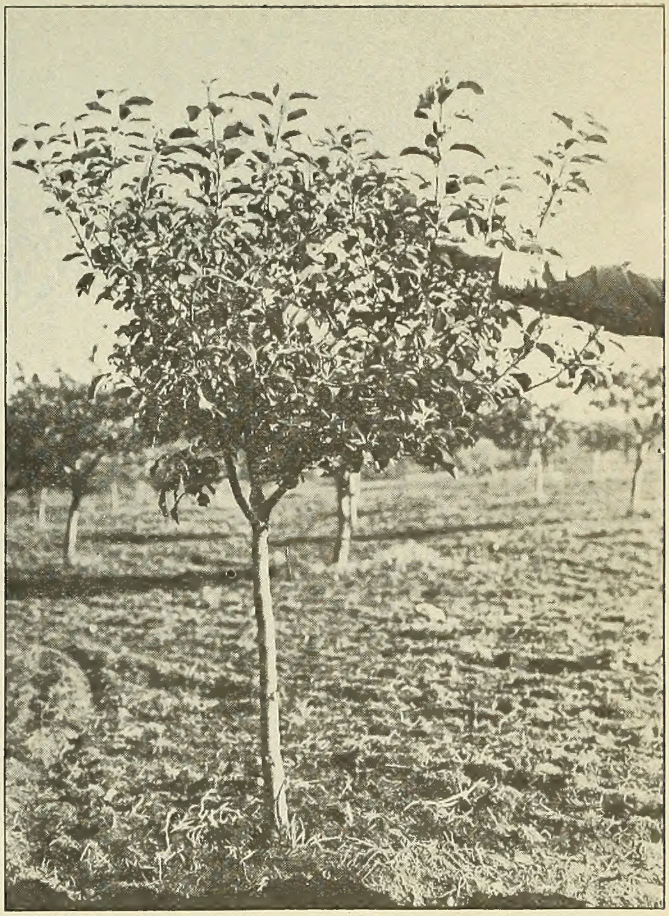

Fig. 13. Young Tree in Baldwin Orchard, July 25, 1911. Seasonal Growth extends above point indicated by hand,

of odd varieties along the roads and in pasture fields, these trees were grouped in five large blocks; one consisted chiefly of Baldwin trees, another of Baldwin and Ben Davis with the admixture of a few Russet, Greening, Mann and Tolman Sweet. The remaining three divisions were practically solid blocks of Ben Davis. According to their composition these orchards are known as the Baldwin, Mixed and Ben Davis Number 1, 2, and 3 respectively.

All of the orchards were at the time of purchase covered with a thick sod of witch grass.

The Baldwin orchard was in the very poorest condition of all. The trees averaged about 10 feet in height and 4 inches in diameter. The heads were high and scant, had very little and poor foliage, bore practically no fruit and appeared to be very badly starved. (Fig. 12) In addition to injury by borers, mice and fungi, the trees had several times in the past been severely damaged by fires in the orchard grass.

The Mixed orchard ranked nearly with the Baldwin in its unsatisfactory condition. The trees were somewhat lower, with an average diameter a little greater than the Baldwin plot. The foliage was also somewhat more abundant, but the trees as a whole indicated great lack of vigor and many were beyond profitable renovation.

Ben Davis No. 1 comprised the greatest number of trees in any one plot, and although in quite unsatisfactory state when the farm was purchased, was in a general condition that promised response to good handling. The trees were mostly well formed, quite uniform, about 15 feet high and 6 inches in diameter, excepting those of more recent planting. The foliage in 1909 was moderate, but not normal in amount or color and suffered a severe attack of fungus leaf spot.

Ben Davis No. 2 was in by far the thriftiest state of all the orchards. The trees were well headed, averaged about 20 feet in height and about 7 inches in diameter. The foliage in 1909 was fair in amount, although not normal in appearance. This orchard had in the past received more attention in the way of plowing and manuring than the others, and at one time had been used as a sheep pasture. These facts account in a large measure for its superior condition. This was the plot reserved for experimental work.

Ben Davis No. 3 gave little promise. This orchard was younger than any of the others, as the trees replaced those originally set which were destroyed by mice, fires in the orchard grass and by lack of drainage, as this was one of the few blocks where water had a tendency to stand. Nearly all the trees were small, lacked vigor, and in many cases were not well rooted. Little was to be expected from this block.

The age and size of the trees varied in nearly all blocks, according as new trees supplanted those destroyed by various agencies. This fact, together with the years of neglect and lack of plant food, made it difficult to more than guess at the age of the trees on the basis of size.

With the exception of Ben Davis No. 2, already noted, the general condition of the trees was extremely bad. The vast majority had never known a pruning knife; fully 75 percent on a general average, had been and were being injured to varying degrees by apple tree borers and girdled by field mice. The damage inflicted by the latter and by insects such as the codling moth, leaf curler, case bearers, tent caterpillars and curculio was very great, and fungus parasites such as leaf spots and scab reduced the vitality of the foliage and damaged the fruit. In addition, the bark of a great number of trees was badly encrusted with growths of lichen.

Aside from the injuries due to living organisms, nearly all the trees showed marked symptoms of lack of plant food. The foliage was notably scant and deficient in healthy green color. Some trees of about two inches in diameter and not over five feet high bore small unmarketable apples,—an indication that injury to the food supply channels had shortened life and abnormally hastened maturity. The continued existence of a thick grass sod had checked the tendency to deep root growth and had reduced the moisture of the soil. The trees were in consequence shallow rooted and not equipped to withstand a season of drought to best advantage.

Only one plot, Ben Davis No. 2, bore fruit to any extent in 1909, although the trees bloomed more or less abundantly in nearly all parts of the orchards. The harvest yielded but 200 barrels, of which only 90 could be packed for market.

In general, then, it may be said that the orchards at the time they came under Station control were in notably bad condition.

Some trees were damaged beyond hope of repair. Others were in doubtful shape, indicating but a chance of response to good treatment. The rest, so far as surface indications warranted, were capable of being brought into thrifty profitable condition by proper methods of orchard renovation.

Table II indicates the condition in the several plots.

TABLE II.

Survey of Orchards, September 1909.

PLOT.	Acres.*	Number of trees.	TO BE REMOVED.		TOTAL NUMBER IN POOR CONDITION.	
			Number.	Per cent.	Number.	Per cent.
Baldwin.........	6.4	447	149	33.3	276	61.7
Mixed...........	7.4	514	105	20.4	304	59.1
Ben Davis, No. 1.	17.8	1,233	152	12.3	230	18.6
Ben Davis, No. 2.	7.6	529	37	7.9	71	13.4
Ben Davis, No. 3.	6.0	418	156	37.3	244	58.3
Total........	45.2	3,141	599	19.0	1,125	35.8

* Acreage estimated on basis of trees existing and not on actual area covered by orchard.

The survey on which the above table is based was made in the fall of the year. Little could be done in the months that preceded in the way of renovation work, as the farm did not come into Station control until midsummer. Nevertheless an attempt was made to check the ravages of insects and fungi by spraying with bordeaux mixture and lead arsenate. About the last of June the trees received a moderate application of chemical fertilizer containing the three necessary elements, nitrogen, phosphorus and potash, at the rate of 300 lbs. per acre. Apparently the witch grass received all the benefit from this, judging by its thrifty condition in September of that year. The trees had to all appearances profited nothing.

In the fall of this year (1909) the orchards received their first pruning. The immense amount of intertwined growth that formed the tops of the trees made necessary a plan of pruning somewhat different than is uusually conducted annually in an orchard in thrifty condition. Had all the wood been removed that season that was necessary for the proper shaping and thinning out of each tree, the result would have been a stimulus to wood growth that would doubtless have delayed the production of fruit for several years. It was, therefore, decided to extend over a period of at least three seasons pruning that might properly have been done at that time, thus gradually shaping the trees to the desired form and at the same time allowing greater opportunity for the formation of fruit buds by avoiding undue vegetative stimulus.

Renovation Work 1910-11.

It was not until the spring of 1910 that general renovation work was started. This included thorough cultivation from early spring until the end of July, the application at plowing time of lime at the rate of 1000 lbs. per acre, followed shortly thereafter by 1500 lbs. per acre of high grade complete chemical fertilizer of 3.3-10-7 formula.* Applications of insecticides and fungicides in the form of lead arsenate and bordeaux mixture were made at the proper times. At the close of cultivation cover crops of vetch or rye were sown, except in one orchard where weeds were allowed to form the winter cover. Twice during this season each tree was carefully examined for borers.

Notable improvement was shown as the result of the first year's work. The large Ben Davis No. 1 showed marked response to treatment and gave promise of good fruit production the next season. Ben Davis No. 2 was as a whole in good condition and superior to all other blocks. Ben Davis No. 3 showed a scattering of thrifty trees; the remainder were removed, as their size, condition and lack of response to treatment rendered them useless for any future experimental work.

For the same reasons it was necessary to remove the orchard of mixed varieties almost in its entirety. So shallow rooted were the trees in this block that practically all were pulled up with their roots with one pair of horses. In many cases the roots ran for 15 to 20 feet from the trunk within 8 inches of the soil surface.

The Baldwin orchard had been reserved in the spring of 1010 for a purely practical renovation experiment, and in the fall of that year this block was squared up into definite shape for that purpose. On account of its extremely poor condition in 1909 this block showed less marked improvement at the end of one year's treatment than did the others.

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* A fertilizer containing 3.3 percent of nitrogen, 10 percent of available phosphoric acid and 7 percent of potash.

The season of 1911 repeated the general operations of 1910 in the several non-experimental blocks, with one or two exceptions; no lime was applied and the amount of fertilizer used per acre was 1000 lbs. of 4-8-7 composition. Lime-sulphur was used as the fungicidal spray in all the orchards in place of bordeaux mixture. Lead arsenate was added as usual to the former to control leaf and fruit destroying insects.

The close of the growing season and the subsequent harvest of the past fall gave results that not only were satisfactory to the Station but should be of interest to fruit growers in the state who are confronted with the problem of orchard renovation.

The Baldwin orchard, apparently in hopeless condition two years previous, has made remarkable progress. (Fig. 13). The trees are fast becoming firmly rooted; the wood growth averaged about 12 inches, the foliage was especially noteworthy for its dark healthy color, great mass and size of leaves and the persistence with which it adhered. Although killed by frost, the foliage in this orchard was still on the trees, not in isolated patches, but as a mass, up to the first of December.

No great amount of fruit was borne here; this was to be expected in view of its former condition. Nevertheless, the larger trees averaged in a number of cases 2 or 3 barrels of large, well colored fruit per tree.

Ben Davis No. 1 has in two seasons been transformed from an unprofitable unthrifty block into a vigorous, bearing orchard, and is now in condition to be used for experimental purposes. The foliage, wood growth, yield and character of fruit left nothing to be desired.

Ben Davis No. 2 (omitting certain experimental plots to be considered later) increased in general thrift, and more than doubled its fruit production over the preceding year. Similar improvement occurred in Ben Davis No. 3 and the trees not in orchard blocks.

The necessary removal in 1910 of the greater part of the block of mixed varieties, the shaping up of the Baldwin orchard and the weeding out of the hopeless trees in Ben Davis No. 3

reduced the total orchard area given in Table 11 to 33 acres,—making, with the addition of the scattering trees, a total of about 2300 in the fall of 1911.

A comparison of the yields (Tables 12 and 13) from 1909 to 1911 inclusive emphasizes the progress more concretely.

TABLE 12.

Annual Yields, 1909-1911.

Year.	Number of trees (approximate).	Total yield in barrels.	Marketable.
1909	3,100	200	90
1910	2,300	350	275
1911	2,300	2,450	2,336*

* Consisting of 2,000 barrels of Fancy and No. 1 grades and 336 barrels No. 2 grade.

TABLE 13.

Annual Yields by Orchards.

1910.		1911	
Baldwin Ben Davis, No. 1 Ben Davis, No. 3 Scattering	146	Baldwin	154
		Ben Davis, No. 1	1,600
		Ben Davis, No. 3 Scattering	231
Ben Davis, No. 2	204	Ben Davis, No. 2	465
Total	350	Total	2,450

The foregoing account of the conditions existing at Highmoor three years ago and of the results since obtained has been made with recognition of the fact that the work so far described has had in itself nothing of experimental nature. Such work was simply a matter of necessity, being incidental to the establishment of the necessary conditions requisite for experimental plots.

On the other hand, while the function of the Station lies in general outside the sphere of purely demonstration work, these results, secondary as they are from the experimental point of view, have value in indicating the possibilities of this kind of work in the neglected orchards throughout the state. What has been done in the Station orchards can be accomplished elsewhere with equal success by the use of a proportionate amount of intelligently applied effort and judicious expenditure.

The latest available census statistics (1900) on apple production show that of the nine states (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania) comprising the North Atlantic Division of the United States, Maine ranks third in the total number of apple trees and seventh in the yield of fruit. In the average number of trees per farm Maine ranks first (104.7), while on the score of yield in bushels per farm this State comes last with a record of 35.6 bushels. While it may be reasonably expected that the census figures of 1910 may show an increase of yield per tree for this State, it must be recognized that the two fundamental problems of the Maine orchardist needing immediate attack are economic. They are (1) increase in the production per unit, and (2) improvement in quality of product.

These are problems in orchard management, involving the factors of soil manipulation, fertilizers and insect and fungus control. As previously stated, the experiments dealing with control of parasites have recently been published by this Station, and the present discussion is confined to the experimental results obtained to date along the other lines.

Of the several million apple trees in this state not over 5 percent, as a conservative estimate, are subject to any regular system of cultivation. Perhaps 25 percent are standing in land pastured to animals,—generally sheep or hogs. The remainder stand in grass, with occasional or no applications of either organic or inorganic fertilizers.

Since these are without doubt the chief conditions relating to the low unit production in this State, they were utilized as the basis for the experimental work begun in 1910.

EXPERIMENTAL WORK, 1910-1911.

As stated above, the experimental work up to the present has of necessity been confined to the one block of trees whose average condition and comparative uniformity, together with the prospect of moderate fruit yield, warranted its use for such purposes. Ben Davis orchard No. 2 was divided in the spring of 1910 as follows:

Spraying experiments with fungicides and insecticides	2.00 acres,	(140 trees).
Sheep pasturage experiment	1.10 “	(76 “).
Hog pasturage experiment	1.10 “	(76 “).
Sod plot. (Check)	0.71 “	(49 “).*
Organic fertilizer experiment	1.18 “	(82 “).
Inorganic fertilizer experiment	1.04 “	(72 “).
Total	7.13 acres,	(495 trees).**

The arrangement of the plots is indicated in the following diagram.

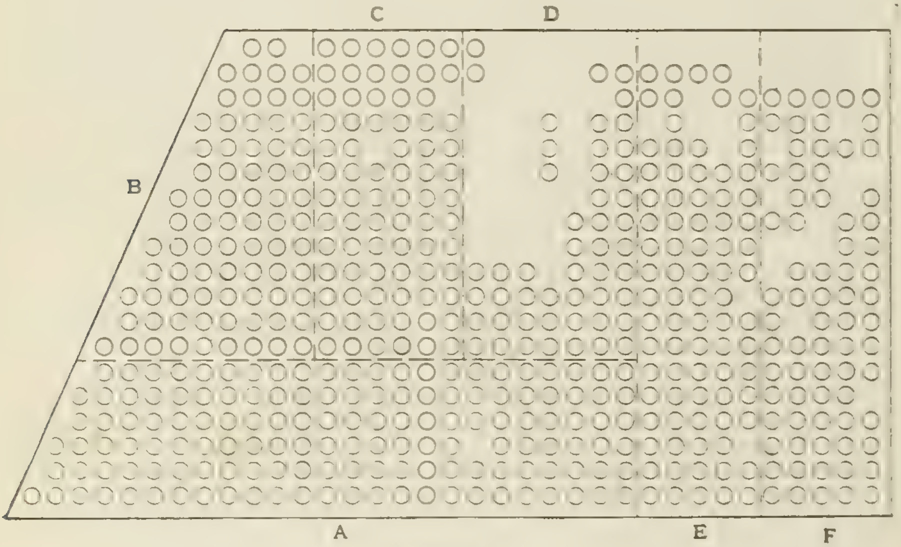

Fig. 14

Diagram of Experiments, Ben Davis Orchard No. 2. 1910-1911. Diagram.

A.—Spraying experiments. B.—Sheep pasturage experiments.
C.—Hog pasturage experiments. D.—Sod plot (check).
E.—Organic fertilizer experiment. F.—Inorganic fertilizer experiment.

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* The number of trees in this plot was later reduced to 37 by omitting 12 trees adjoining the organic fertilizer plot.

**Tree acreage here given is less than that given in Table 11, p. 37, owing to removal of 34 trees.

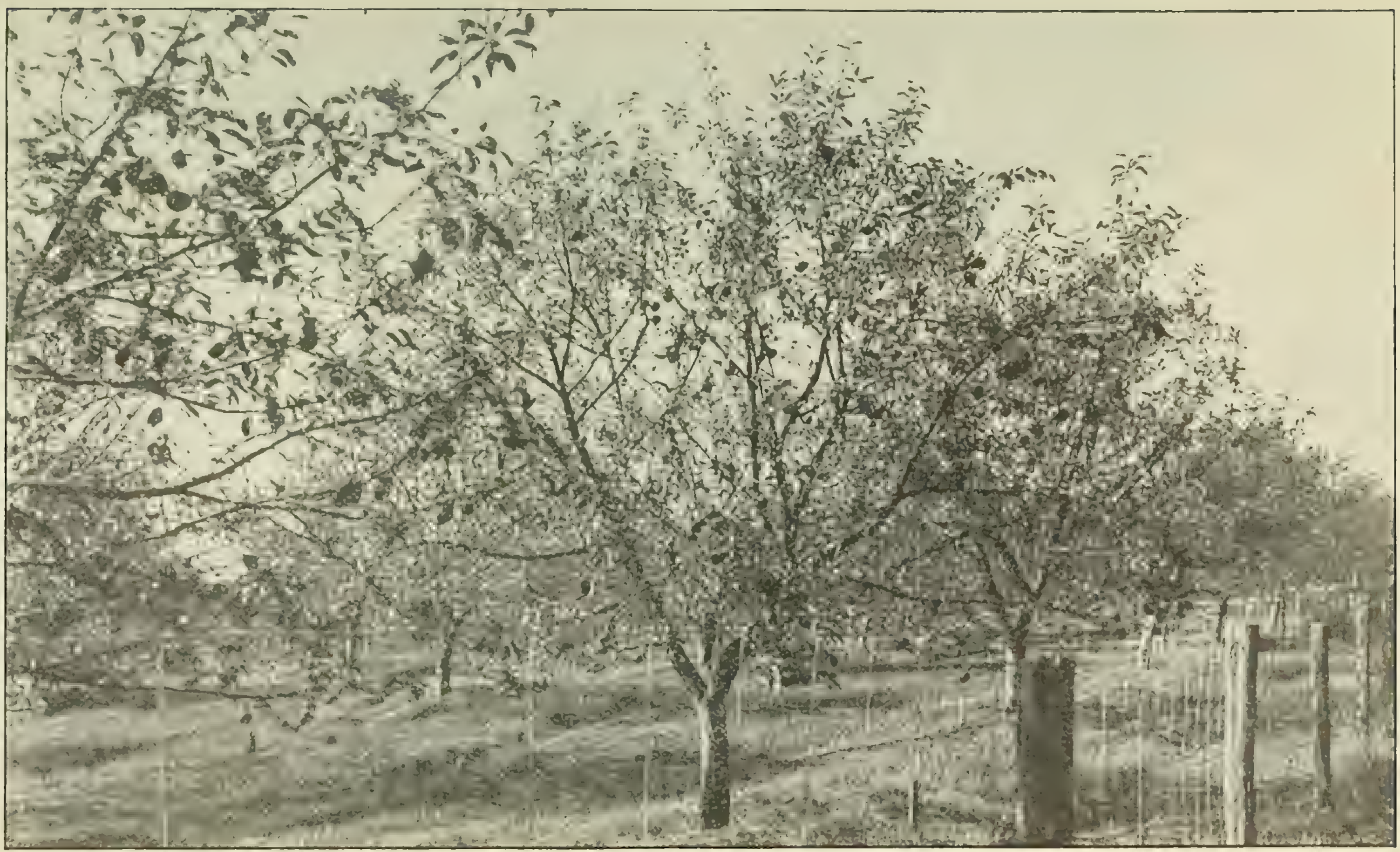

Fig. 15. Trees in Plot B, Oct. 3, 1910.

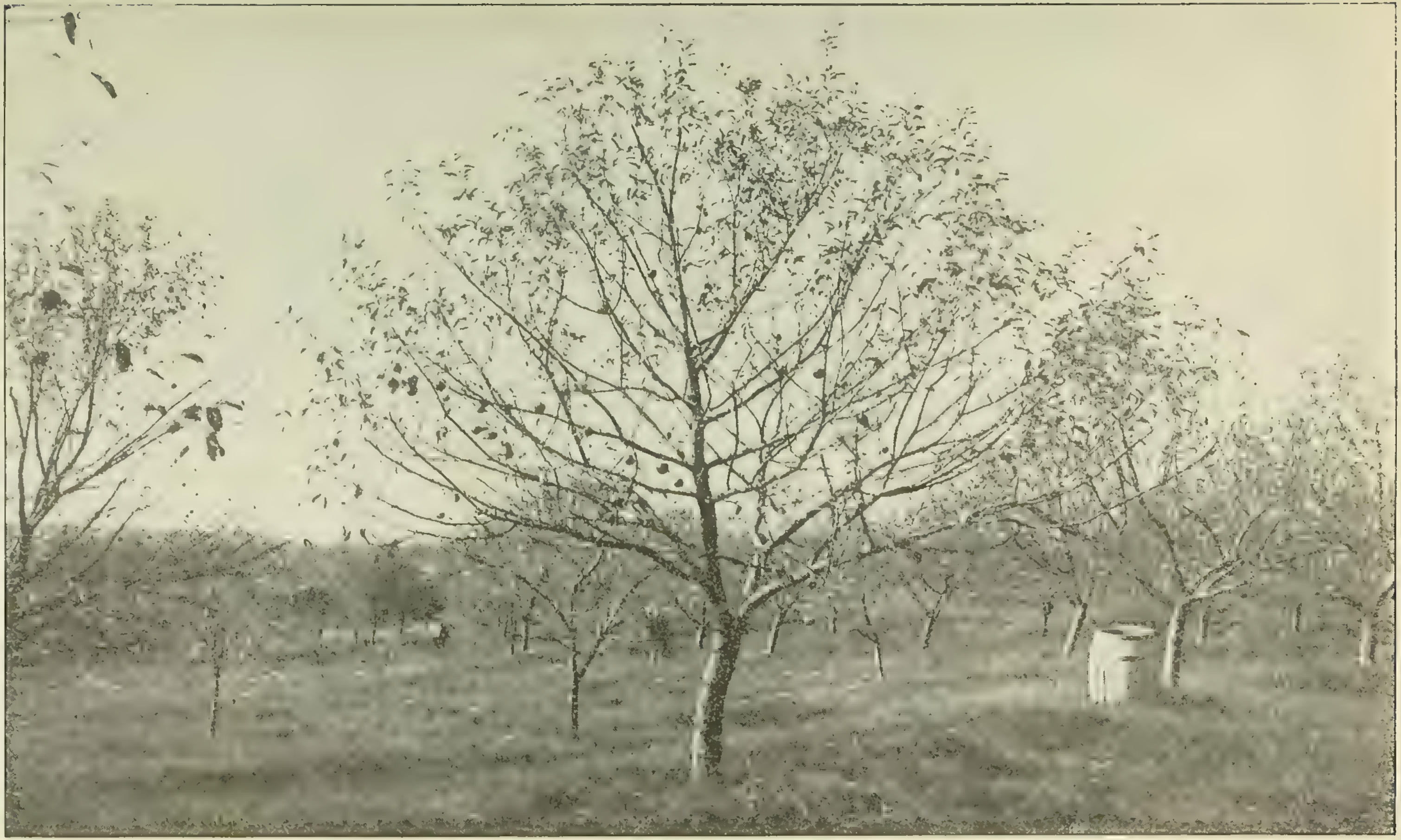

Fig. 16. Trees in Plot D, Oct. 3, 1910.

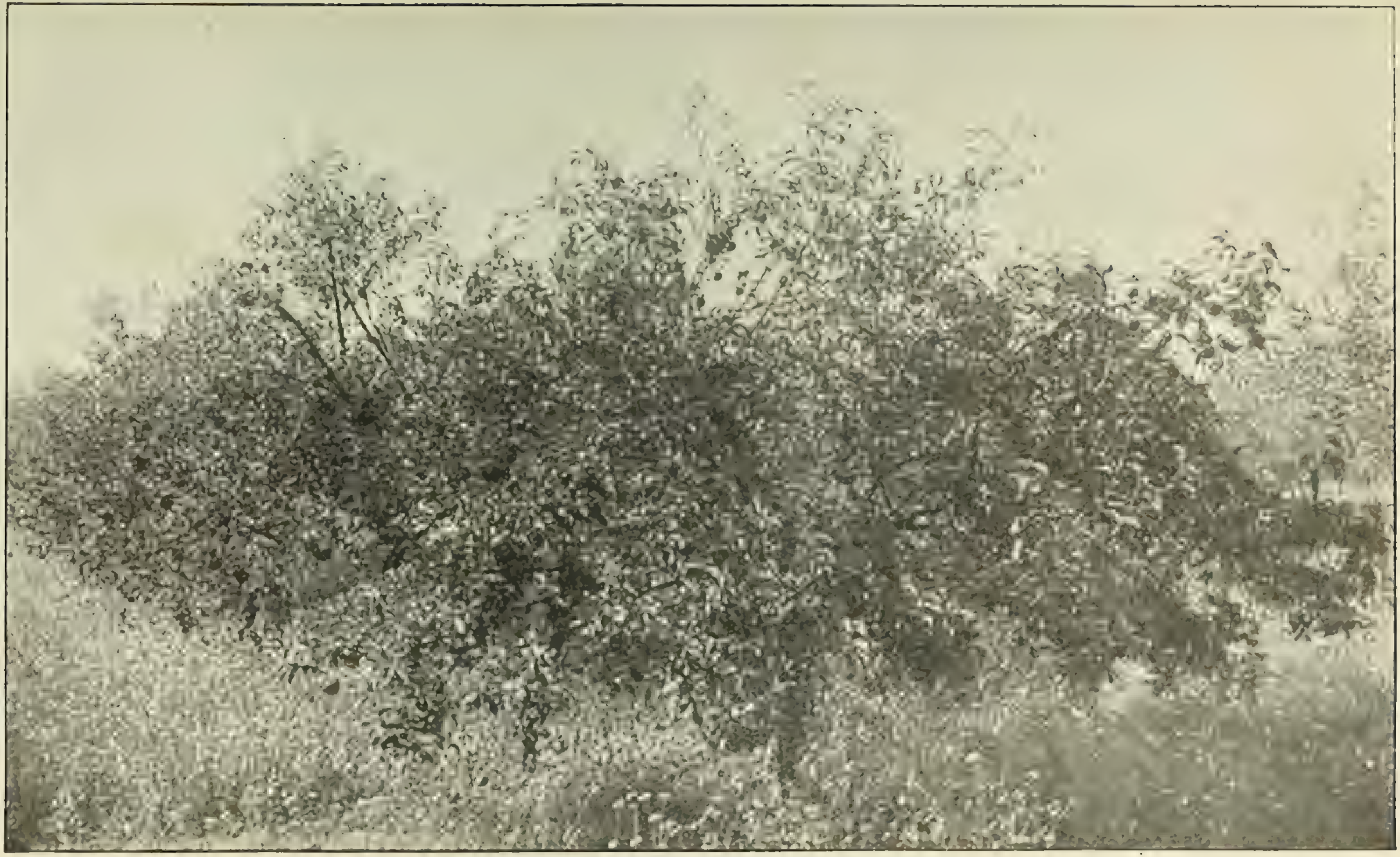

Fig. 17. Trees in Plot A, Oct. 3, 1910.

Treatment 1910. All six plots were pruned according to the need of each tree and all except A were thoroughly sprayed three times during the season with bordeaux mixture and lead arsenate. Plot A was treated with lime-sulphur and bordeaux according to the experiments described in the publications referred to.

Plots A and F received an application of chemical fertilizer of 3.3-10-7 formula at the rate of 1500 lbs. per acre. Plot E received 6 cords of barnyard manure. No fertilizer was applied to Plots B, C and D during this season. B and C were fenced and 5 sheep and 5 brood sows were turned into the respective plots about the first of May. Sod was broken in A, E and F about the last week in April, and cultivation was continued throughout the season up to August 1. Then winter vetch was sown in these three plots as a cover crop. The animals in the two plots were removed at the close of harvest.

Treatment 1911. Treatment was identical with that of the preceding year, except that all plots, with the omission of E, received 1000 lbs. of chemical fertilizer of 4-8-7 composition. Lime-sulphur and lead arsenate were the spray materials used.

General Notes. Comparative and specific data are given in tables to follow. In general the results so far obtained seem to indicate most strikingly that the chief factor accountable for low production per tree is the lack of cultivation.

It must be remembered that in 1909 the condition of all the trees in this entire experimental orchard, even making due allowance for the few cases of difference in size and age, was not uniform. However, the trees showed no greater differences in vigor or lack thereof than would be observed in any block of trees planted presumably at one time, and having experienced the same treatment or neglect for an indefinite period; and this, of course, holds true for their condition in the spring of 1910.

By the close of the season, however, the difference in amount and color of foliage between the cultivated and the uncultivated divisions was significant. The yield of fruit, although comparatively small for the entire orchard, showed notable plot differences, wherever the size of trees allowed a fair basis of comparison.

The foliage in Plots B, C and D withstood the dry summer of 1910 poorly. Disregarding the early leaf yellowing, for which bordeaux spray injury may have been accountable, the leaves were light in color and small. Lack of vigor and vastly insufficient growth were everywhere evident in the sheep, hog and sod plots. Defoliation began early and before harvest the appearance of the trees was that indicated in Figs. 15 and 16.

In Plots A, E and F the reverse of the above conditions obtained. Foliage was dark green, abundant (Fig. 17) and adhered until frost killed it. No noteworthy differences in this respect were seen between the three plots under cultivation nor between the two pastured to animals. Plot D was in poorer condition, however, than either B or C. The fruit yield, as will be seen later, showed equally strikingly differences.

In 1911, as already noted, it was decided to topdress the uncultivated plots to see if the plant food so applied would show any effect. No decided improvement resulted. The foliage in plots B, C and D was again far inferior in amount, color and size of leaves to that of A, E or F. A few isolated instances occurred in plot C where a tree was prominent among its neighbors for increased vigor. Such were trees around which the hogs had done enough rooting to destroy the sod entirely, and in a way had performed the work of cultivation. It is worthy of note that practically all of the trees in all the non-cultivated divisions that showed any noticeable improvement were on the boundary row of their respective plots,—i. e. one-fourth of their root systems, theoretically, had felt the stimulus of cultivation.

Much of the inhibition to growth of trees in sod is of course accounted for by lack of needed water. The grass roots absorb the greater part of the available surface soil moisture before the latter has time to reach the lower soil. This moisture is lost through the processes of growth, and the soil water from the greater depths is drawn up by physical forces and likewise dissipated through the grass growth.

To a small extent this competition for water between grass and tree roots was reduced in the uncultivated plots in these experiments. The sheep kept the grass well cropped, and the hogs, although they rooted very unevenly, did in a measure check the growth of grass. On the sod plot an attempt was made to conserve soil moisture and check the sod growth by cutting the grass at intervals and leaving it to form a mulch. In none of these divisions, however, was there any observable benefit.

RESULTS.

Notes on the several points presented in the following tables have been made for each tree during the past two seasons. The data is of necessity governed by a personal factor, as must be the case when classifications are made, as they had to be in this work, by general observations. For example, a "showy" bloom in the eyes of one man would appear to be only "full" to another. Nevertheless the data are fairly comparable, since results for both seasons are from the notes of one observer.

Plot A is used as the cultivated plot in these tables as a basis for comparison with B, C and D because of the more uniform size of the trees and the relation of the plots in the orchard (see Fig. 14). The rows in B, C and D are simply the extensions of the respective rows in A.

TABLE 14.

Size of Trees.

	1910.				1911.			
Plot.	Total number.	Per cent. large.	Per cent. medium.	Per cent. small.	Total number.	Per cent. large.	Per cent. medium.	Per cent. small.
A.....	140	38.5	52.1	9.2	139	38.8	51.7	9.3
B.....	76	51.3	42.1	6.5	74	52.7	41.8	5.4
C.....	76	36.8	55.2	7.8	76	36.8	55.2	7.8
D.....	37	48.6	18.9	32.4	37	48.6	18.9	32.4

One tree, it will be noted, was removed at the close of 1910. The great percentage of the trees in all plots are medium or large and of commercial bearing age. In plot D the percent of small trees exceeds that of medium ones.

TABLE 15.

Degree of Bloom.

Plot.	1910.					1911.				
	Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.	Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.
A........	–	92.1	2.8	4.2	0.7	1.4	25.1	30.9	35.9	6.4
B........	–	92.1	6.5	1.3	–	–	1.3	10.8	68.8	18.9
C........	–	90.7	2.6	5.2	1.3	–	5.2	15.7	71.0	7.8
D........	–	54.0	13.5	21.6	10.8	–	–	5.4	62.1	32.4

It will be noted here that the bloom was excellent in 1910, much better, indeed, than in 1911. The flower buds of the former year had of course been formed before the Station acquired the orchards. It is not given for comparison with the bloom of 1911; the noteworthy comparison is that between the above table and those following, showing the percent of fruit actually set, and the yields of the plots.

TABLE 16.

Fruit Set.

Plot.	1910.				1911.			
	Per cent. abundant.	Per cent. medium.	Per cent. poor.	Per cent. none.	Per cent. abundant	Per cent. medium.	Per cent. poor.	Per cent. none.
A.....	22.1	47.1	27.8	2.8	23.0	53.9	17.2	5.7
B.....	43.4	31.5	22.3	2.6	–	6.7	54.0	39.1
C.....	13.1	31.5	50.0	5.2	–	18.4	71.0	10.5
D.....	16.2	32.4	35.1	16.2	–	10.8	59.4	29.7

TABLE 17.

Yield in Barrels and Relative Gain or Loss.

	1910.			1911.			
Plot.	Number of trees.	Number of barrels.	Per cent. of total.	Number of trees.	Number of barrels.	Per cent. of total.	Per cent. gain or loss in 1911.
A...	140	121.25	73.37	139	254.50	81.66	Gain, 109.89
B...	76	25.00	15.12	74	13.40	4.30	Loss, 46.40
C...	76	9.00	5.44	76	32.18	10.32	Gain, 257.55
D...	37	10.00	6.05	37	11.54*	3.70	Gain, 15.40
Total.........		165.25		Total...	311.62		

* Of this yield 7.54 barrels were picked from 11 trees bordering on Plot E, and therefore partially subjected to influence of cultivation.

TABLE 18.

Yield per Tree.

1910.		1911.	
Plot.	Barrels.	Barrels.	Gain or loss.
A................	0.86	1.83	Gain, 0.97 barrels.
B................	0.32	0.18	Loss, 0.14 "
C................	0.11	0.42	Gain, 0.31 "
D................	0.27	0.31	Gain, 0.04 "

TABLE 19.

Yield per Tree, Discarding all Non-Bearing Trees.

1910.		1911.	
Plot.	Barrels.	Barrels.	Gain or loss.
A................	0.89	1.94	Gain, 1.05 barrels.
B................	0.33	0.29	Loss, 0.04 "
C................	0.12	0.50	Gain, 0.38 "
D................	0.32	0.44	Gain, 0.12 "

A comparison of Tables 15 and 16 indicates a very good bloom in 1910 for all trees except the sod plot. Of this bloom, considering the relatively small percent of fruits that are formed in proportion to the number of blossoms on any tree, it may be said that the fruit set (Table 16) for that year was fairly good in the first three plots. In fact plot B promised at fruit setting time to equal, if not exceed, A in proportionate yield. Table 17, however, shows the contrary to be true. Of all four plots, the one that received cultivation and available plant food early in the season was the only one in which the trees could not only set fruit, but could to a reasonable degree carry, develop and mature it. In the uncultivated plots the dropping of the fruits at an early date after setting accounts largely for the discrepancy between set and yield. The food reserve was not sufficient to carry the fruit through the season. The trees under cultivation were sufficiently stimulated to action to perform the necessary functions for fruit development.

The bloom of 1911 was far below that of the preceding year in abundance (Table 15). Likewise the fruit set was greatly reduced in all plots, except the cultivated one, where it was slightly better. Bearing in mind, however, that plot A yielded in 1910 almost three-fourths of the entire crop from this orchard, it might reasonably have been expected that B, C and D would increase their proportional yields and that A's yield might prove proportionally smaller than in 1910. Nevertheless, Table 17 shows a total yield almost double that of the preceding year, for four-fifths of which A is again responsible. Of the three uncultivated plots, D made a fair percentage gain in yield over the preceding year and B suffered loss, but C was the only uncultivated plot to show a high percentage increase in its contribution to the total yield of 1911, compared with the proportion it formed of the 1910 crop. The percentage gain, moreover, must be considered in relation to the size of the crops in the two years.

Table 18 shows the relative yield per tree with respective gain or loss in barrels. This is based on the total number of trees per plot. Table 19 shows similar data, omitting in every case the trees that failed to bear fruit; i. e., the data in this table show the comparative yield per bearing tree. Both of these tables show that the normal yield of fruit, even from the cultivated plot, is much below the normal for trees of the size and age under consideration. The significance of the results lies in the differences so far obtained, and the fact that but one year of cultivation has in the main, been responsible therefor. Whether the fertilizer applied in the uncultivated plots in 1911 will affect the fruit yield of the coming season remains to be determined. Certainly no obvious results were obtained in the way of wood growth or improved foliage, except in the isolated instances in plot C, already noted.

The past season, although characterized by great drought during the greater part of the growing period, resulted nevertheless in the production of large, well colored fruit. In this respect, relation of size to culture is indicated by Fig. 18 which shows the *average* size of apples from A, and Fig. 19, showing a similar average for D. The fruits of B and C were on the average equal in size to the largest specimen shown in Fig. 19. Contrary to general rule, the cultivated plots produced fruit of higher color and finer finish than that from the other divisions.

The observations and results of the last two years, therefore, point most decidedly to the conclusion that orchards in Maine with conditions similar or worse than those existing at Highmoor in 1909 cannot be successfully rejuvenated by any system that does not involve the factor of cultivation. This is exposition of no new doctrine, but the numerical data given above may serve to emphasize the fact that increased apple production in the immediate future depends on the rejuvenation of the existing trees of bearing age, and that no single factor of the several involved in orchard management is so potent in bringing about the desired results as proper tillage.

RESULTS FROM FERTILIZER PLOTS.

In view of the short existence of this experiment nothing can be said regarding the effect of the two forms of fertilizer in question. The trees of both plots average closely in point of vigor. The foliage of plot E was perhaps slightly darker and the annual growth somewhat greater the past season than in Plot F.

The fruit yields from plots E and F have been meager compared with plot A. The results are also somewhat difficult to compare justly, owing to the considerable differences in the size of trees in the two plots.

TABLE 20.

Size of Trees.

	1910.				1911.			
Plot.	Number of trees.	Per cent. large.	Per cent. medium.	Per cent. small.	Number of trees.	Per cent. large.	Per cent. medium.	Per cent. small.
E.....	82	42.6	43.9	13.4	82	42.6	43.9	13.4
F.....	72	8.3	61.6	30.5	70	8.5	42.8	28.5

Plot E contains on the percentage basis more than 5 times as many large trees as F, almost one-fourth less of medium size, and less than half as many classed as small.

TABLE 21.

Degree of Bloom.

	1910.					1911.				
Plot.	Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.	Per cent. showy.	Per cent. full.	Per cent. medium.	Per cent. scant.	Per cent. none.
E........	–	79.2	9.7	8.5	2.4	–	8.5	35.3	52.4	3.6
F........	–	62.5	16.6	12.5	8.3	–	20.0	20.0	55.7	4.2

TABLE 22.

Fruit Set.

	1910.				1911.			
Plot.	Per cent. abundant.	Per cent. medium.	Per cent. poor.	Per cent. none.	Per cent. abundant.	Per cent. medium.	Per cent. poor.	Per cent. none.
E.....	14.6	40.2	37.8	7.3	7.3	26.8	62.1	3.6
F.....	15.2	20.8	40.2	23.6	8.5	41.4	45.7	4.2

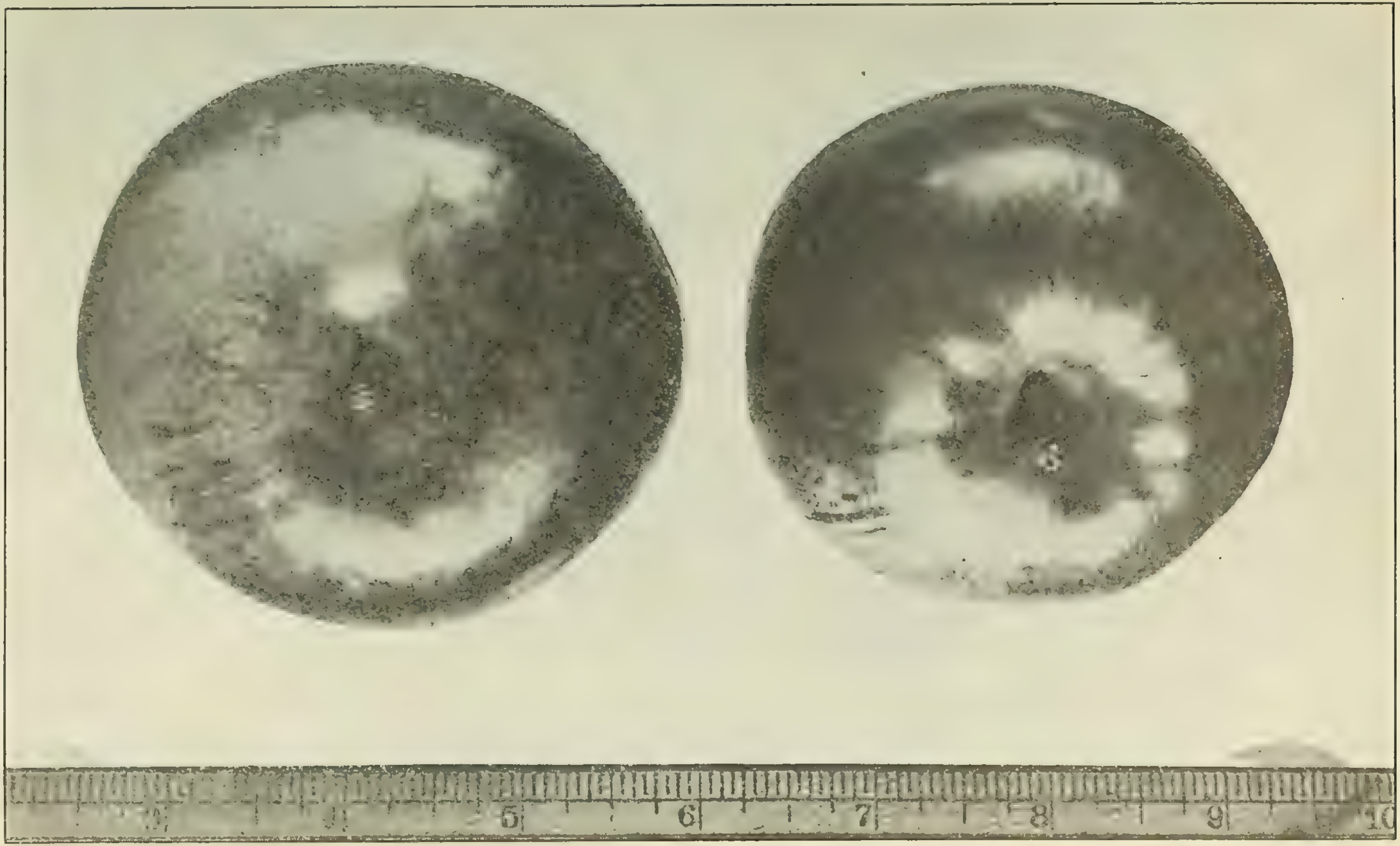

Fig. 18. Average Size of Ben Davis Fruit. Plot A, 1911.

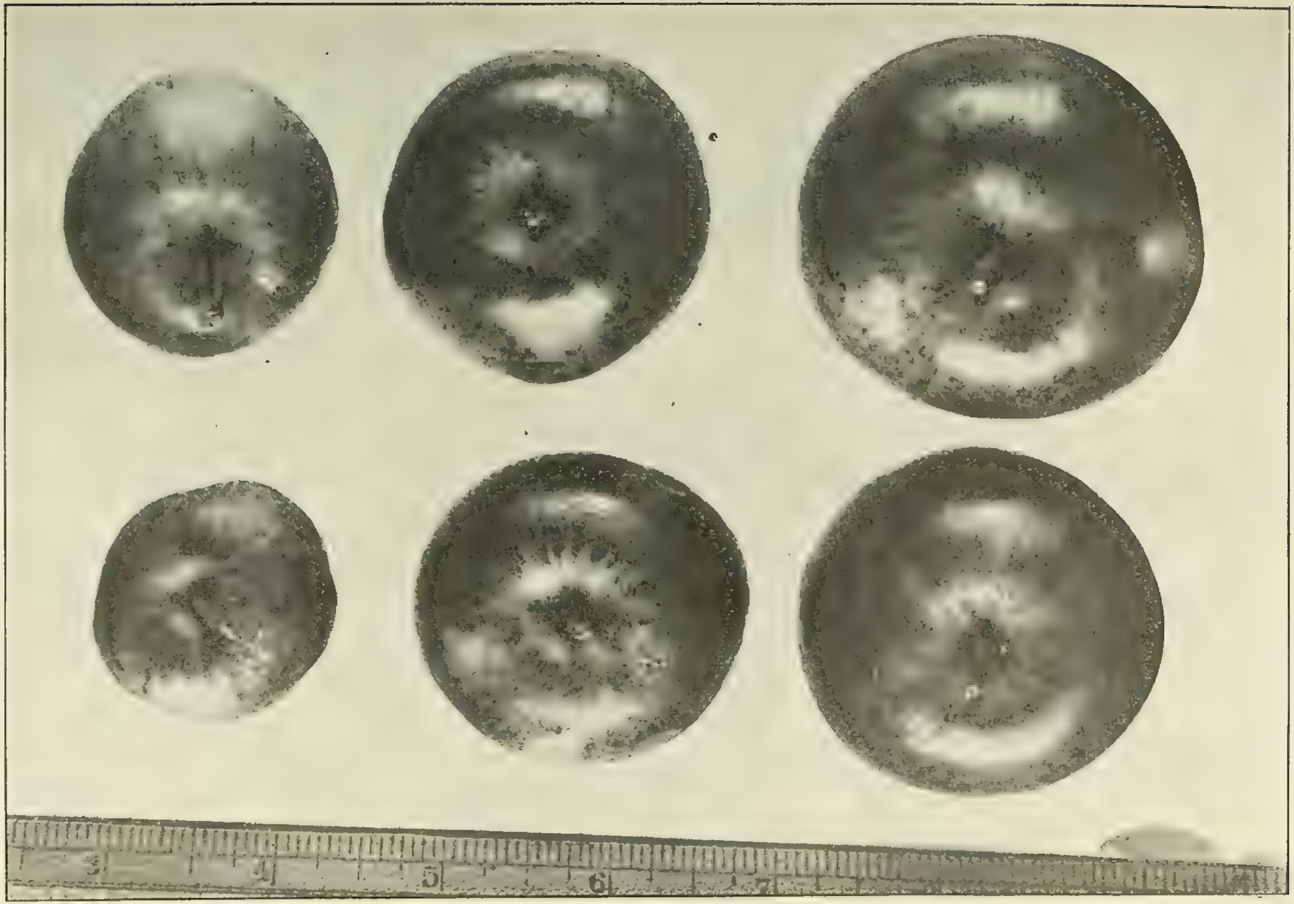

Fig. 19. Average Size of Ben Davis Fruit. Plot D, 1911.

Table 22 shows that here, as in the other plots already considered, the bloom was excellent in 1910. Fairly good percents of abundant and full sets were partially offset by the trees of medium or no set. Nevertheless the 1910 yield, indicated in the next table, is far below the amount reasonably anticipated from the respective set of fruit.

On the other hand, the 1911 data of tables 21, 22, 23 and 24 show a degree of bloom greatly reduced from that of the preceding year, a strikingly greater proportional set of fruit and an equally notable increase in the crop.

It is well to here reiterate the point that however small the actual crop of fruit from these plots may be, it is the increased yield per tree and the percent of increase indicated in the following tables that are full of meaning. The fact that these results have been obtained within the second season of the experiment gives the data an added significance.

TABLE 23.

Yield in Barrels, and Relative Gain.

1910.		1911.	
Plot.	Number of barrels.	Number of barrels.	Per cent. gain in 1911.
E..............	30	92.9	209.66
F..............	9	59.7	563.33

TABLE 24.

Yield per Tree.

1910.			1911.			
Plot.	Number of trees.	Number of barrels.	Number of trees.	Number of barrels.	Gain in barrels.	Per cent. gain in 1911.
E.....	82	0.36	82	1.13	0.77	113.88
F......	72	0.12	70	0.82	0.70	583.33

POMOLOGICAL NOTES.

A Successful Method for Emasculating Blossom Buds.

Experiments in the artificial fecundation of pome fruits has in all known instances been characterized by a surprisingly small percent of successes in proportion to the number of blossoms pollinated. Allowing for poor technique in pollination or improper preservation of pollen, the success of such work has seemed to the writer to depend to a large degree upon the manipulation of the blossom bud in castration. In the breeding work inaugurated last spring this question was considered as one of the important points to be determined in developing a successful technique.

The methods generally recommended by horticultural experimenters is to entirely remove the petals before castration, either by grasping them at the apex of the bud and pulling them off, or by cutting them away. In this manner greater freedom is obtained in removing the stamens.

Such procedure would appear to be undesirable and not conducive to successful results. The method most likely to insure a fair degree of success would be, theoretically, one which combines the necessary emasculation with the minimum disturbance to the organism. Removal of floral parts may be followed by results analagous to surgical shock in animals. In addition, the removal of petals and stamens is doubtless followed by drying out processes at the points of severance.

The emasculation at this Station was therefore made without removal of either petals or filaments. The buds were carefully opened by prying apart and laying back the enfolded petals. The anthers were then removed with the minimum portion of filament by means of a small thin bladed scalpel with straight cutting edge tapering to an acute V.

In this way buds measuring 7 mm. axially were castrated, and developed into full bloom in bags without suffering apparent disturbance from the emasculation process. Buds of more advanced stages were operated upon with greater rapidity and ease, with similar results. The fruits obtained in the crossing work of the past season, although comparatively few in number, all resulted from buds emasculated by the above method. No fruits were set on blossoms whose petals were removed before castration.

It is hoped that a repetition of the method, coupled with the scheme of pollen preservation suggested by Simon * will result in a larger percent of successful crosses than has heretofore been made.

TERATOLOGY.

The season of 1911 was most favorable to the production of apples of great size; hence it may be properly assumed that the climatic factors affecting rapidity of growth may have had some relation to the comparatively large number of abnormal fruits reported in various apple growing sections of the country.

Figs. 20 and 21 show a double Baldwin apple found at Highmoor during the past season. The two distinct calices (Fig. 20) would indicate a duplication of floral parts in the blossom. Fig. 21 illustrates the attachment to a common stem, and the normally developed seeds within the carpels of the two independent cores. The only tissues common to both individuals of this fruit pair are those of the stem, flesh and skin.

Less common than double fruits is the abnormal development shown in Figs. 22 and 23. Apples exhibiting this unusual growth were found in surprisingly large numbers in orchards in Greene during the summer of 1911. They were about equally frequent on Baldwin and Greening; the illustrations are from one of the latter variety.

Examinations of this outgrowth showed a striking resemblance to a calyx lobe. It was pubescent, of grayish brown color, triangular in form, the base developing from the skin, and the apex recurved. In most cases it was nearer the basin than the cavity, and the base of this so-called lobe was connected with the calyx cluster by a slight lineal depression or a light line of color in the skin. In the majority of such apples examined there appeared to be but four normally developed calyx lobes in the basin of the fruit (Fig. 23),—a fact which inclines one to the belief that such growth is an abnormally located calyx lobe. The actual cause of this phenomenon rests on a morphological examination and the determination of the point of growth in the apple.

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*Simon, J., Gartenwelt, 15 (1911), No. 7, "A New Method of Preserving Flower Pollen in a Viable Condition," Abst., E. S. R. 24: 6, p. 543.

WINTER INJURY.

Following the winter of 1910-1911 a considerable amount of winter injury to the trunks of trees was noted in a number of localities in the several orchard divisions. This injury took the form of a severe loosening and splitting of the bark of the trunk; in the less serious cases longitudinal splits occurred, extending through the living tissues to the wood. The bark immediately about these splits either stood free from the wood or else was very loosely attached thereto.

These less severe cases healed to some degree during the past season, to the extent that loosely adhering bark became more firmly attached. In the great majority of cases the injury had been severe enough to cause complete sloughing of the injured tissues with the advent of warm weather, leaving the wood exposed.

All gradations of the latter type of damage were found, from cases where a small area the size of a hand had been affected to a few extreme instances where the tree had been practically girdled for several feet from the ground.

Treatment has been the same as that for removal of a diseased area,—namely, cutting away of all dead tissues, disinfecting the exposed surfaces and protecting them with a coat of paint. In this way, the greater part of the trees affected will doubtless heal over; those most severely damaged, however, give little hope of recovery.

The cause of this kind of injury is not known with any certainty, and the question calls for extended study. The common assumption that the growth of the season preceding the winter in which the injury occurred had not sufficiently ripened before the advent of cold weather, does not apply here. The trees incurring the greatest damage made, on the whole, less wood growth than the vast majority that came through the winter unharmed. Neither can sun-scald be held directly responsible for the trouble, in view of the fact that the injury occurred as frequently upon the northern as upon the southern sides of the trees.

In the absence of specific experiments bearing on this question, two factors would seem to have a relation to this type of winter injury. They are insufficient soil drainage and a sudden

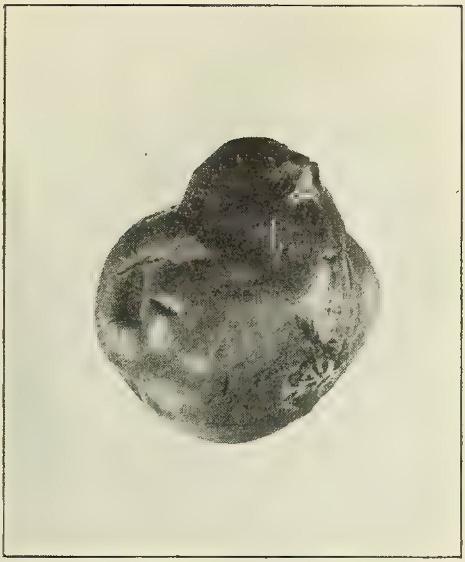


Fig. 20. Double of "Twin" Apple.

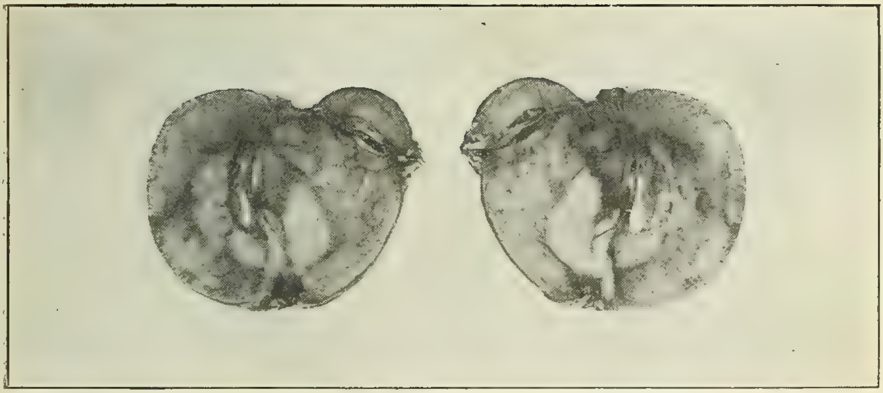
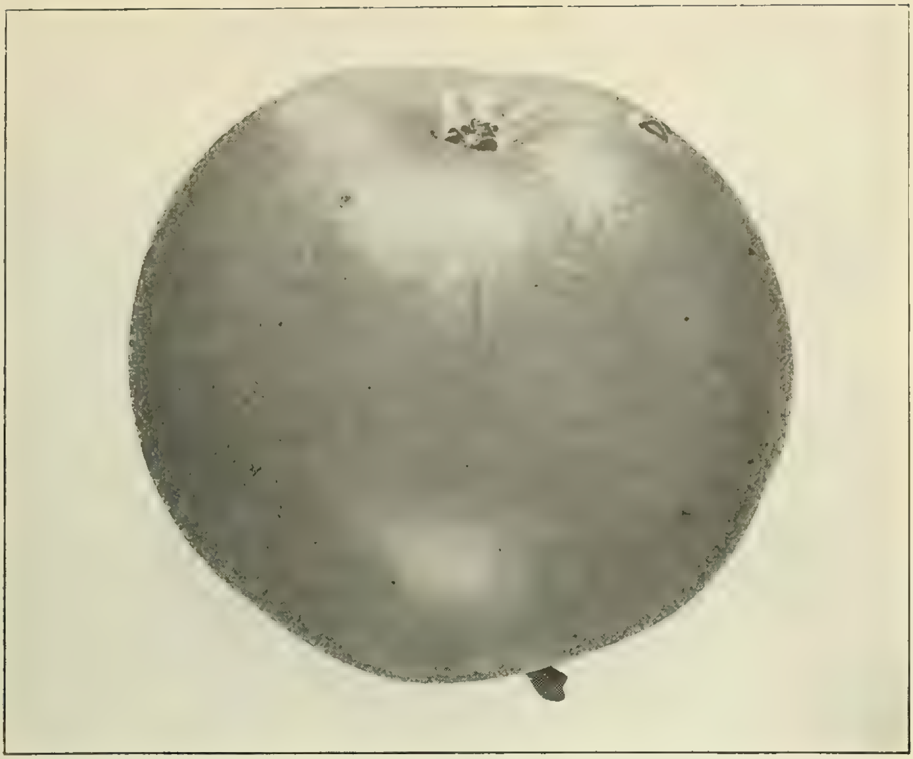


Fig. 21. Section Through Double Apple.



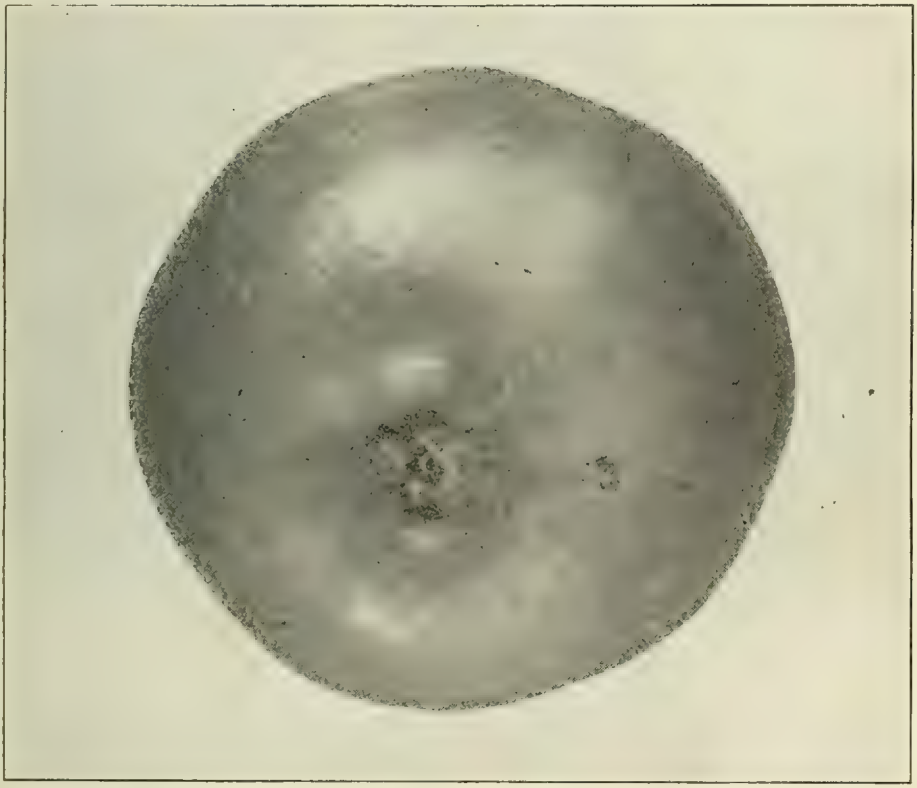


Fig. 22 and Fig. 23. Greening, Showing Skin Resembling Calyx Lobe.

temperature drop below the freezing point, following a period of warm weather.

A significant fact is that the trees most severely affected were confined to a small group standing in a slight depression that serves as a drain for the slightly higher ground surrounding. The cases of lesser injury also indicate the probable relation of topography and consequent drainage to the injury. Land which collects a greater amount of soil moisture than neighboring areas will, if said moisture is not excessive and other conditions are equal, tend to produce in trees growing therein a greater response to temperatures inducing plant activity.

The records for the winter of 1910-1911 show that from January to the end of March several periods of temperatures high for those months were followed by sudden and rather great drops below the freezing point. The hypothesis is that the warm periods referred to induced considerable activity in some trees, so that when the temperature fell suddenly close to 30 degrees Fahr. cleavage of bark from wood occurred by the freezing of the water-containing tissues of the former. The trees responding most actively were those in locations of highest soil moisture content. Those in dryer soil responded slowly enough to suffer no damage.

ANNOUNCEMENT.

There are three lines of apple studies that from the beginning have stood out as the important ones to be undertaken at Highmoor Farm. These are orchard management, investigations upon apple enemies, and investigations in apple propagation and growth. Orchard management covers such questions as cultivation, fertilization, pruning, cover crops, thinning of fruit and protection from insects and fungi. These more practical questions call for the work of an experienced orchardist and one familiar with the grosser field experiments. The apple diseases require the expert scientist skilled in plant pathology. To be of real permanent value these call for more than superficial investigation. Their study demands the expert botanist to discover, classify, and learn the life habits of the low forms of plant life that cause the injuries. He must have knowledge and ability to study the differences between fungi that are accidentally present because of the damaged and diseased tissue and those that are the cause of the injury. He must have that intimate knowledge with plant physiology that makes it possible for him readily and surely to distinguish between normal and abnormal growth, between healthy and pathological tissues. The work in propagation and growth demands the trained biologist. On the one hand the skill and knowledge requisite to the breeder of plants and on the other that of the biometrician who is trained to measure growth accurately. Orchard management demands the skilled operative, the other questions demand the highly trained scientific specialists.

During the past three years the work in orchard management has been under the control of the horticulturist and the studies upon apple enemies have been made in cooperation with the plant pathologist and those in breeding with the biologist. With the resignation of Mr. Bonns as horticulturist all of the apple work will be planned by a committee consisting of the director, the biologist and the plant pathologist. The details of the work will be carried out by and under the personal supervision of Mr. Yeaton who has been appointed orchardist.

CHAS. D. WOODS,
Director.